Assignment 3: Data Exploration

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Fall 2024

OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on Data Exploration.

Directions

1. Rename this file `<FirstLast>_A03_DataExploration.Rmd` (replacing `<FirstLast>` with your first and last name).
2. Change "Student Name" on line 3 (above) with your name.
3. Work through the steps, **creating code and output** that fulfill each instruction.
4. Assign a useful **name to each code chunk** and include ample **comments** with your code.
5. Be sure to **answer the questions** in this assignment document.
6. When you have completed the assignment, **Knit** the text and code into a single PDF file.
7. After Knitting, submit the completed exercise (PDF file) to the dropbox in Canvas.

TIP: If your code extends past the page when knit, tidy your code by manually inserting line breaks.

TIP: If your code fails to knit, check that no `install.packages()` or `View()` commands exist in your code.

Set up your R session

1. Load necessary packages (tidyverse, lubridate, here), check your current working directory and upload two datasets: the ECOTOX neonicotinoid dataset (ECOTOX_Neonicotinoids_Insects_raw.csv) and the Niwot Ridge NEON dataset for litter and woody debris (NEON_NIWO_Litter_massdata_2018-08_raw.csv). Name these datasets "Neonics" and "Litter", respectively. Be sure to include the subcommand to read strings in as factors.

```
#setting up
library(tidyverse); library(lubridate); library(here) #load packages

here() #check working directory
```

```
## [1] "/home/guest/EDE_Fall2024"
```

```r
#load data sets:
Neonics <- read.csv(
  file = here("./Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv"),
  stringsAsFactors = TRUE)   #load and name neonics

#view(Neonics)

Litter <- read.csv(
  file = here("./Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv"),
  stringsAsFactors = TRUE)   #load and name litter

#view(Litter)
```

Learn about your system

2. The neonicotinoid dataset was collected from the Environmental Protection Agency's ECOTOX Knowledgebase, a database for ecotoxicology research. Neonicotinoids are a class of insecticides used widely in agriculture. The dataset that has been pulled includes all studies published on insects. Why might we be interested in the ecotoxicology of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

   Answer:We might be interested in this topic if we were researching certain insects or the effect of neonicotioids on ecosytems more generally. These chemicals are harmful to many beneficial insects like pollinators and aquatic invertebrates, both of which are integral to the health of their ecosytems.

3. The Niwot Ridge litter and woody debris dataset was collected from the National Ecological Observatory Network, which collectively includes 81 aquatic and terrestrial sites across 20 ecoclimatic domains. 32 of these sites sample forest litter and woody debris, and we will focus on the Niwot Ridge long-term ecological research (LTER) station in Colorado. Why might we be interested in studying litter and woody debris that falls to the ground in forests? Feel free to do a brief internet search if you feel you need more background information.

   Answer:So I actually was working at NEON before coming to school! I was on the flora team so I did both the litter and fine woody debris protocols. I'm so excited that we're using their data! Litter is very important in nutrient cylcling in a forest; so we might be interested to know how much carbon for example is being mineralized through the litter.

4. How is litter and woody debris sampled as part of the NEON network? Read the NEON_Litterfall_UserGuide.pdf document to learn more. List three pieces of salient information about the sampling methods here:

   Answer: 1.Elevated traps are set out that catch litter. The litter is collected from them in the spring and fall 2.Ground traps are designated rectangles of ground where fine woody debris is collected once a year 3. The samples of litter are taken back to the lab and sorted by type i.e. leaves, seeds, flowers, etc.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```r
#dimensions of dataset?
colnames(Neonics) #column names of dataset
```

```
##  [1] "CAS.Number"                        "Chemical.Name"
##  [3] "Chemical.Grade"                    "Chemical.Analysis.Method"
##  [5] "Chemical.Purity"                   "Species.Scientific.Name"
##  [7] "Species.Common.Name"               "Species.Group"
##  [9] "Organism.Lifestage"                "Organism.Age"
## [11] "Organism.Age.Units"                "Exposure.Type"
## [13] "Media.Type"                        "Test.Location"
## [15] "Number.of.Doses"                   "Conc.1.Type..Author."
## [17] "Conc.1..Author."                   "Conc.1.Units..Author."
## [19] "Effect"                            "Effect.Measurement"
## [21] "Endpoint"                          "Response.Site"
## [23] "Observed.Duration..Days."          "Observed.Duration.Units..Days."
## [25] "Author"                            "Reference.Number"
## [27] "Title"                             "Source"
## [29] "Publication.Year"                  "Summary.of.Additional.Parameters"
```

```r
str(Neonics) #structure and dimensions of dataset
```

```
## 'data.frame':    4623 obs. of  30 variables:
##  $ CAS.Number                      : int  58842209 58842209 58842209 58842209 58842209 58842209 5884
##  $ Chemical.Name                   : Factor w/ 9 levels "(1E)-N-[(6-Chloro-3-pyridinyl)methyl]-N-ethy
##  $ Chemical.Grade                  : Factor w/ 9 levels "Analytical grade",..: 9 9 9 9 9 9 9 9 9 9 .
##  $ Chemical.Analysis.Method        : Factor w/ 5 levels "Measured","Not coded",..: 4 4 4 4 4 4 4 4 4
##  $ Chemical.Purity                 : Factor w/ 80 levels ">=98",">=99.0",..: 69 69 50 50 50 50 50 50
##  $ Species.Scientific.Name         : Factor w/ 398 levels "Acalolepta vastator",..: 69 69 248 248 248
##  $ Species.Common.Name             : Factor w/ 303 levels "Alfalfa Leafcutter Bee",..: 74 74 142 142
##  $ Species.Group                   : Factor w/ 4 levels "Insects/Spiders",..: 1 1 1 1 1 1 1 1 1 ..
##  $ Organism.Lifestage              : Factor w/ 20 levels "Adult","Cocoon",..: 1 1 19 19 19 1 19 1 1 1
##  $ Organism.Age                    : Factor w/ 39 levels "<=24","<=48",..: 39 39 39 39 39 36 39 36 3
##  $ Organism.Age.Units              : Factor w/ 11 levels "Day(s)","Days post-emergence",..: 9 9 4 4 4
##  $ Exposure.Type                   : Factor w/ 24 levels "Choice","Dermal",..: 23 23 11 11 11 11 11 1
##  $ Media.Type                      : Factor w/ 10 levels "Agar","Artificial soil",..: 7 7 3 3 3 3 3 3
##  $ Test.Location                   : Factor w/ 4 levels "Field artificial",..: 4 4 4 4 4 4 4 4 4 4 .
##  $ Number.of.Doses                 : Factor w/ 30 levels "' 4-5","' 4-7",..: 30 30 18 18 18 18 18 18
##  $ Conc.1.Type..Author.            : Factor w/ 3 levels "Active ingredient",..: 1 1 1 1 1 1 1 1 1 1
##  $ Conc.1..Author.                 : Factor w/ 1006 levels "<0.0004","<0.025",..: 639 510 813 622 442
##  $ Conc.1.Units..Author.           : Factor w/ 148 levels "%","% v/v","% w/v",..: 132 132 91 91 91 91
##  $ Effect                          : Factor w/ 19 levels "Accumulation",..: 16 16 16 16 16 16 16 16 1
##  $ Effect.Measurement              : Factor w/ 155 levels "Abundance","Accuracy of learned task, peri
##  $ Endpoint                        : Factor w/ 28 levels "EC10","EC50",..: 15 15 8 8 8 8 8 8 8 8 ...
##  $ Response.Site                   : Factor w/ 19 levels "Abdomen","Brain",..: 14 14 14 14 14 14 14 1
##  $ Observed.Duration..Days.        : Factor w/ 361 levels "<.0002","<.0021",..: 145 145 145 145 145 1
##  $ Observed.Duration.Units..Days.  : Factor w/ 17 levels "Day(s)","Day(s) post-emergence",..: 1 1 1 1
##  $ Author                          : Factor w/ 433 levels "Abbott,V.A., J.L. Nadeau, H.A. Higo, and M
##  $ Reference.Number                : int  107388 107388 103312 103312 103312 103312 103312 103312 103
##  $ Title                           : Factor w/ 458 levels "A Common Pesticide Decreases Foraging Succ
##  $ Source                          : Factor w/ 456 levels "Acta Hortic.1094:451-456",..: 295 295 296
##  $ Publication.Year                : int  1982 1982 1986 1986 1986 1986 1986 1986 1986 1986 ...
##  $ Summary.of.Additional.Parameters: Factor w/ 943 levels "Purity: \xca NC - NC | Organism Age: \xca
```

6. Using the `summary` function on the "Effect" column, determine the most common effects that are studied. Why might these effects specifically be of interest? [Tip: The `sort()` command is useful for listing the values in order of magnitude...]

```
#What are the most common effects that are studied?
sort(summary(Neonics$Effect))
```

```
##       Hormone(s)        Histology       Physiology          Cell(s)
##                1                5                7                9
##     Biochemistry     Accumulation     Intoxication    Immunological
##               11               12               12               16
##       Morphology           Growth       Enzyme(s)         Genetics
##               22               38               62               82
##        Avoidance      Development     Reproduction Feeding behavior
##              102              136              197              255
##         Behavior        Mortality       Population
##              360             1493             1803
```

Answer: Population is the most common effects studied. These are probably of specific interest because studying the population of an insect species can tell you a lot about the overall health and wellbeing of the species and its reaction to insecticide.

7. Using the `summary` function, determine the six most commonly studied species in the dataset (common name). What do these species have in common, and why might they be of interest over other insects? Feel free to do a brief internet search for more information if needed.[TIP: Explore the help on the `summary()` function, in particular the `maxsum` argument...]

```
#6 most commonly studied species in dataset?
sort(summary(Neonics$Species.Common.Name))
```

```
##                          Ant Family                         Apple Maggot
##                                   9                                    9
##              Glasshouse Potato Wasp                             Lacewing
##                                  10                                   10
##             Southern House Mosquito             Two Spotted Lady Beetle
##                                  10                                   10
##           Spotless Ladybird Beetle                 Braconid Parasitoid
##                                  11                                   12
##                        Common Thrip        Eastern Subterranean Termite
##                                  12                                   12
##                              Jassid                           Mite Order
##                                  12                                   12
##                           Pea Aphid                   Pond Wolf Spider
##                                  12                                   12
##               Armoured Scale Family                   Diamondback Moth
##                                  13                                   13
##                       Eulophid Wasp                   Monarch Butterfly
##                                  13                                   13
##                       Predatory Bug               Yellow Fever Mosquito
##                                  13                                   13
##                        Corn Earworm                   Green Peach Aphid
##                                  14                                   14
```

```
##                       House Fly                         Ox Beetle
##                              14                                14
##               Red Scale Parasite               Spined Soldier Bug
##                              14                                14
##           Western Flower Thrips Hemlock Woolly Adelgid Lady Beetle
##                              15                                16
##           Hemlock Wooly Adelgid                              Mite
##                              16                                16
##                     Onion Thrip             Araneoid Spider Order
##                              16                                17
##                       Bee Order                   Egg Parasitoid
##                              17                                17
##                    Insect Class          Moth And Butterfly Order
##                              17                                17
##      Oystershell Scale Parasitoid          Black-spotted Lady Beetle
##                              17                                18
##                    Calico Scale               Fairyfly Parasitoid
##                              18                                18
##                     Lady Beetle            Minute Parasitic Wasps
##                              18                                18
##                      Mirid Bug                  Mulberry Pyralid
##                              18                                18
##                      Silkworm                    Vedalia Beetle
##                              18                                18
##                    Codling Moth         Flatheaded Appletree Borer
##                              19                                20
##             Horned Oak Gall Wasp                Leaf Beetle Family
##                              20                                20
##                Potato Leafhopper         Tooth-necked Fungus Beetle
##                              20                                20
##                   Argentine Ant                            Beetle
##                              21                                21
##                      Mason Bee                          Mosquito
##                              22                                22
##                Citrus Leafminer                   Ladybird Beetle
##                              23                                23
##                Spider/Mite Class               Tobacco Flea Beetle
##                              24                                24
##                    Chalcid Wasp            Convergent Lady Beetle
##                              25                                25
##                   Stingless Bee              Ground Beetle Family
##                              25                                27
##                Rove Beetle Family                     Tobacco Aphid
##                              27                                27
##                    Scarab Beetle                     Spring Tiphia
##                              29                                29
##                     Thrip Order            Ladybird Beetle Family
##                              29                                30
##                      Parasitoid                     Braconid Wasp
##                              30                                33
##                    Cotton Aphid                   Predatory Mite
##                              33                                33
##              Sweetpotato Whitefly                      Aphid Family
##                              37                                38
```

```
##                     Cabbage Looper              Buff-tailed Bumblebee
##                                 38                                 39
##                   True Bug Order          Sevenspotted Lady Beetle
##                                 45                                 46
##                     Beetle Order       Snout Beetle Family, Weevil
##                                 47                                 47
##               Erythrina Gall Wasp                  Parasitoid Wasp
##                                 49                                 51
##            Colorado Potato Beetle                    Parastic Wasp
##                                 57                                 58
##              Asian Citrus Psyllid                Minute Pirate Bug
##                                 60                                 62
##                European Dark Bee                          Wireworm
##                                 66                                 69
##                   Euonymus Scale                Asian Lady Beetle
##                                 75                                 76
##                  Japanese Beetle                 Italian Honeybee
##                                 94                                113
##                       Bumble Bee              Carniolan Honey Bee
##                                140                                152
##             Buff Tailed Bumblebee                   Parasitic Wasp
##                                183                                285
##                        Honey Bee                           (Other)
##                                667                                670
```

```
help(summary) #what is a 'maxsum'?
sort(summary(Neonics$Species.Common.Name, maxsum = 670))
```

```
##              Antlike Flower Beetle   Banded Soft-winged Flower Beetle
##                                  1                                  1
##              Banded Sunflower Moth                         Bee Family
##                                  1                                  1
##                     Beet Armyworm                 Black Citrus Aphid
##                                  1                                  1
##                Blue Alfalfa Aphid                   Cabbage Root Fly
##                                  1                                  1
##                Cactus Lady Beetle                    Citrus Red Mite
##                                  1                                  1
##               Cottony Cushion Sale                  Crapemyrtle Aphid
##                                  1                                  1
##                  Damselbug Family                Ectoparasitoid Wasp
##                                  1                                  1
##                English Grain Aphid                          Fairyfly
##                                  1                                  1
##                        Flea Beetle                         Gall Midge
##                                  1                                  1
##   Grasshopper/Cricket/Locust Order                Greenhouse Whitefly
##                                  1                                  1
##         Grey Sunflower Seed Weevil            Harvestman Spider Order
##                                  1                                  1
##                Hawthorn Leaf Miner      Longtailed Fruit Fly Parasite
##                                  1                                  1
##                Minute Lady Beetles                Painted Maple Aphid
##                                  1                                  1
```

```
##                   Pepper Weevil                Pine False Webworm
##                               1                                 1
##                      Plant Bug                   Pollen Beetle
##                               1                                 1
##                Predacious Mite                    Predator Bug
##                               1                                 1
##            Pseudocentipede Class           Pteromalid Wasp Family
##                               1                                 1
##         Red Sunflower Seed Weevil            Rice Leaf Folder Moth
##                               1                                 1
##                Rose Grain Aphid              Scale Picnic Beetle
##                               1                                 1
##              Shiny Spider Beetle              Southern Army Worm
##                               1                                 1
##                   Spirea Aphid     Spotted Sunflower Stem Weevil
##                               1                                 1
##         Strawberry Blossom Weevil                  Sunflower Midge
##                               1                                 1
##                 Sunflower Moth          Ten-spot Ladybird Beetle
##                               1                                 1
##                  Tobacco Thrip          Twicestabbed Lady Beetle
##                               1                                 1
##                    Wasp Family                           Weevil
##                               1                                 1
##            Yellow Mealworm Beetle               Alfalfa Plant Bug
##                               1                                 2
##                     Alkali Bee                             Aphid
##                               2                                 2
##                   Assassin Bug                Azalea Lace Bug
##                               2                                 2
##                   Banana Aphid                    Brown Scale
##                               2                                 2
##                 Brown Stinkbug                        Budworm
##                               2                                 2
##                  Cabbage Aphid                   Cabbage White
##                               2                                 2
##                  Cardamom Thrip                   Carrot Weevil
##                               2                                 2
##                Celer Crab Spider                 Centipede Class
##                               2                                 2
##                 Citricola Scale               Clouded Plant Bug
##                               2                                 2
##              Coffee Bean Weevil               Cotton Fleahopper
##                               2                                 2
##           Egyptian Alfalfa Weevil                 Engraver Beetle
##                               2                                 2
##              Fig Longicorn Beetle        Glassy-winged Sharpshooter
##                               2                                 2
##                Hawthorn Lace Bug             Hister Beetle Family
##                               2                                 2
##              Jumping Spider Family               Lined Click Beetle
##                               2                                 2
##                Maple Spider Mite                Meshweaver Spider
##                               2                                 2
```

```
##           Minute Pirate Bug Family                    Predaceous Fly
##                                  2                                 2
##               Pygmy Mangold Beetle                       Rose Sawfly
##                                  2                                 2
##               Serpentine Leafminer               Spider Mite Destroyer
##                                  2                                 2
##         Spotted Tentiform Leafminer                         Stink Bug
##                                  2                                 2
##                 Tawny Mole Cricket             Tick/Chigger/Mite Order
##                                  2                                 2
##                 Turf Running-spider                      Turnip Aphid
##                                  2                                 2
##                 Western Bigeyed Bug                 Western Damsel Bug
##                                  2                                 2
##                   Western Plant Bug         White Apple Leafhopper Nymph
##                                  2                                 2
##           White-backed Planthopper              Whitemarked Fleahopper
##                                  2                                 2
##               Ambrosia Bark Beetle              Asian Ambrosia Beetle
##                                  3                                 3
##                     Beetle Family                    Birch Leafminer
##                                  3                                 3
##                   Black Twig Borer            Braconid Parasitoid Wasp
##                                  3                                 3
##               California Red Scale               Crucifer Flea Beetle
##                                  3                                 3
##                            Cutworm              Delphacid Planthopper
##                                  3                                 3
##           Egyptian Cotton Leafworm                Encyrtid Parasitoid
##                                  3                                 3
##           Fly/Mosquito/Midge Order       Formosan Subterranean Termite
##                                  3                                 3
##           Fruit-tree Pinhole Borer              Green Rice Leafhopper
##                                  3                                 3
##                     Ground Beetle                   Ichneumonid Wasp
##                                  3                                 3
##      Large-Jawed Orb Weaver Family                   Leaf Cutting Ant
##                                  3                                 3
##            Mediterranean Fruit Fly                   Minute Flour Bug
##                                  3                                 3
##                       Mite Family                        Moth Family
##                                  3                                 3
##                 Negatoria Canegrub                  Sap Beetle Family
##                                  3                                 3
##                 Scale Insect Order               Scarab Beetle Family
##                                  3                                 3
##            Sheet-Web Weaver Family                            Spider
##                                  3                                 3
##                     Sugarcane Grub                 Tenebrionid Beetle
##                                  3                                 3
##                                Ant              Cabbage Seedpod Weevil
##                                  4                                 4
##               Common Green Lacewing               Eucalyptus Gall Wasp
##                                  4                                 4
```

```
##              European Apple Sawfly                European Honey Bee
##                                  4                                 4
##       European Tarnished Plant Bug                 Garden Symphylan
##                                  4                                 4
##                  Linyphiid Spider                     Onion Maggot
##                                  4                                 4
##                   Oriental Beetle                 Parsnip Seed Wasp
##                                  4                                 4
##                Pea And Bean Weevil                      Pear Sucker
##                                  4                                 4
##              Red Imported Fire Ant            Striped Cucumber Beetle
##                                  4                                 4
##                 Sugarcane Beetle                                Wasp
##                                  4                                 4
##                 Wolf Spider Family             Yellow-faced Bumblebee
##                                  4                                 4
##                       Apple Aphid                  Brown Planthopper
##                                  5                                 5
##                             Earwig                  Green June Beetle
##                                  5                                 5
##                     Hornfaced Bee           Long Horned Beetle Family
##                                  5                                 5
##                     Plum Curculio                       Rove Beetle
##                                  5                                 5
##                    San Jose Scale                    Scelionid Wasp
##                                  5                                 5
##              Speckled Cutworm Moth                      Thrip Family
##                                  5                                 5
##                   Ambrosia Beetle                       Aphid Wasp
##                                  6                                 6
##                 Black Vine Weevil                 Childers Canegrub
##                                  6                                 6
##               Coconut Leaf Beetle       Elevenspotted Ladybird Beetle
##                                  6                                 6
##                     Encyrtid Wasp                 European Red Mite
##                                  6                                 6
##                     Fall Armyworm                          Fruit Fly
##                                  6                                 6
##                         Hover Fly          Oblique Banded Leaf Roller
##                                  6                                 6
##                  Obscure Mealybug             Oribatid Mite Suborder
##                                  6                                 6
##                Pistachio Psyllid             Redbay Ambrosia Beetle
##                                  6                                 6
##               Silverleaf Whitefly                     Soybean Aphid
##                                  6                                 6
##              Subterranean Termite                             Thrip
##                                  6                                 6
##           Two-Spotted Spider Mite                 Beetle Mite Family
##                                  6                                 7
##                       Chinch Bug               Macedonian Honey Bee
##                                  7                                 7
##                             Moth                   Potato Tuberworm
##                                  7                                 7
```

```
##               Russian Wheat Aphid                    Soldier Beetle
##                                 7                                 7
##         Southern One-Year Canegrub              Tarnished Plant Bug
##                                 7                                 7
##             Alfalfa Leafcutter Bee                               Bee
##                                 8                                 8
##                         Bumblebee            Chilean Predatory Mite
##                                 8                                 8
##                  Dwarf Honey Bee         Neotropical Stingless Bee
##                                 8                                 8
##              Parasitic Wasp Family              Spiralling Whitefly
##                                 8                                 8
##                         Ant Family                     Apple Maggot
##                                 9                                 9
##                 Asiatic Honey Bee               Eulophid Parasitoid
##                                 9                                 9
##                  Lacewing Family                Mealybug Destroyer
##                                 9                                 9
##             Glasshouse Potato Wasp                          Lacewing
##                                10                                10
##           Southern House Mosquito           Two Spotted Lady Beetle
##                                10                                10
##          Spotless Ladybird Beetle               Braconid Parasitoid
##                                11                                12
##                      Common Thrip      Eastern Subterranean Termite
##                                12                                12
##                            Jassid                        Mite Order
##                                12                                12
##                         Pea Aphid                  Pond Wolf Spider
##                                12                                12
##             Armoured Scale Family                 Diamondback Moth
##                                13                                13
##                     Eulophid Wasp                 Monarch Butterfly
##                                13                                13
##                     Predatory Bug             Yellow Fever Mosquito
##                                13                                13
##                      Corn Earworm                 Green Peach Aphid
##                                14                                14
##                         House Fly                          Ox Beetle
##                                14                                14
##                Red Scale Parasite                Spined Soldier Bug
##                                14                                14
##             Western Flower Thrips Hemlock Woolly Adelgid Lady Beetle
##                                15                                16
##             Hemlock Wooly Adelgid                              Mite
##                                16                                16
##                       Onion Thrip             Araneoid Spider Order
##                                16                                17
##                         Bee Order                    Egg Parasitoid
##                                17                                17
##                      Insect Class           Moth And Butterfly Order
##                                17                                17
##       Oystershell Scale Parasitoid          Black-spotted Lady Beetle
##                                17                                18
```

```
##                   Calico Scale              Fairyfly Parasitoid
##                             18                             18
##                    Lady Beetle          Minute Parasitic Wasps
##                             18                             18
##                      Mirid Bug              Mulberry Pyralid
##                             18                             18
##                      Silkworm               Vedalia Beetle
##                             18                             18
##                   Codling Moth      Flatheaded Appletree Borer
##                             19                             20
##              Horned Oak Gall Wasp             Leaf Beetle Family
##                             20                             20
##                 Potato Leafhopper      Tooth-necked Fungus Beetle
##                             20                             20
##                  Argentine Ant                         Beetle
##                             21                             21
##                     Mason Bee                       Mosquito
##                             22                             22
##                Citrus Leafminer               Ladybird Beetle
##                             23                             23
##                Spider/Mite Class             Tobacco Flea Beetle
##                             24                             24
##                     Chalcid Wasp          Convergent Lady Beetle
##                             25                             25
##                  Stingless Bee            Ground Beetle Family
##                             25                             27
##               Rove Beetle Family                 Tobacco Aphid
##                             27                             27
##                  Scarab Beetle                 Spring Tiphia
##                             29                             29
##                    Thrip Order          Ladybird Beetle Family
##                             29                             30
##                     Parasitoid                 Braconid Wasp
##                             30                             33
##                   Cotton Aphid                Predatory Mite
##                             33                             33
##             Sweetpotato Whitefly                  Aphid Family
##                             37                             38
##                 Cabbage Looper          Buff-tailed Bumblebee
##                             38                             39
##                 True Bug Order     Sevenspotted Lady Beetle
##                             45                             46
##                   Beetle Order  Snout Beetle Family, Weevil
##                             47                             47
##               Erythrina Gall Wasp              Parasitoid Wasp
##                             49                             51
##            Colorado Potato Beetle                Parastic Wasp
##                             57                             58
##              Asian Citrus Psyllid             Minute Pirate Bug
##                             60                             62
##                 European Dark Bee                      Wireworm
##                             66                             69
##                  Euonymus Scale              Asian Lady Beetle
##                             75                             76
```

```
##                    Japanese Beetle                    Italian Honeybee
##                                 94                                 113
##                        Bumble Bee                 Carniolan Honey Bee
##                                140                                 152
##              Buff Tailed Bumblebee                      Parasitic Wasp
##                                183                                 285
##                         Honey Bee
##                                667
```

Answer:The 6 most commonly studied species excluding the Other category are the Honey Bee, the Parasitic Wasp, the Buff Tailed Bumblebee, The Carniolan Honey Bee, the Bumble Bee, and the Italian Honeybee. All of these except for the Parasitic Wasp are in the family Apidae. These might be of interest over other insects because the family Apidae contains many important pollinators, and you wouldn't want to use insecticide on your crops and kill the insects that pollinate them. Parasitic Wasps also prey on a lot of insects that are detrimental to agricultural crops so you would not want to harm them with insecticide either.

8. Concentrations are always a numeric value. What is the class of `Conc.1..Author.` column in the dataset, and why is it not numeric? [Tip: Viewing the dataframe may be helpful...]

```
#Class of column?
str(Neonics$Conc.1..Author.)
```

```
##  Factor w/ 1006 levels "<0.0004","<0.025",..: 639 510 813 622 442 637 500 642 814 784 ...
```

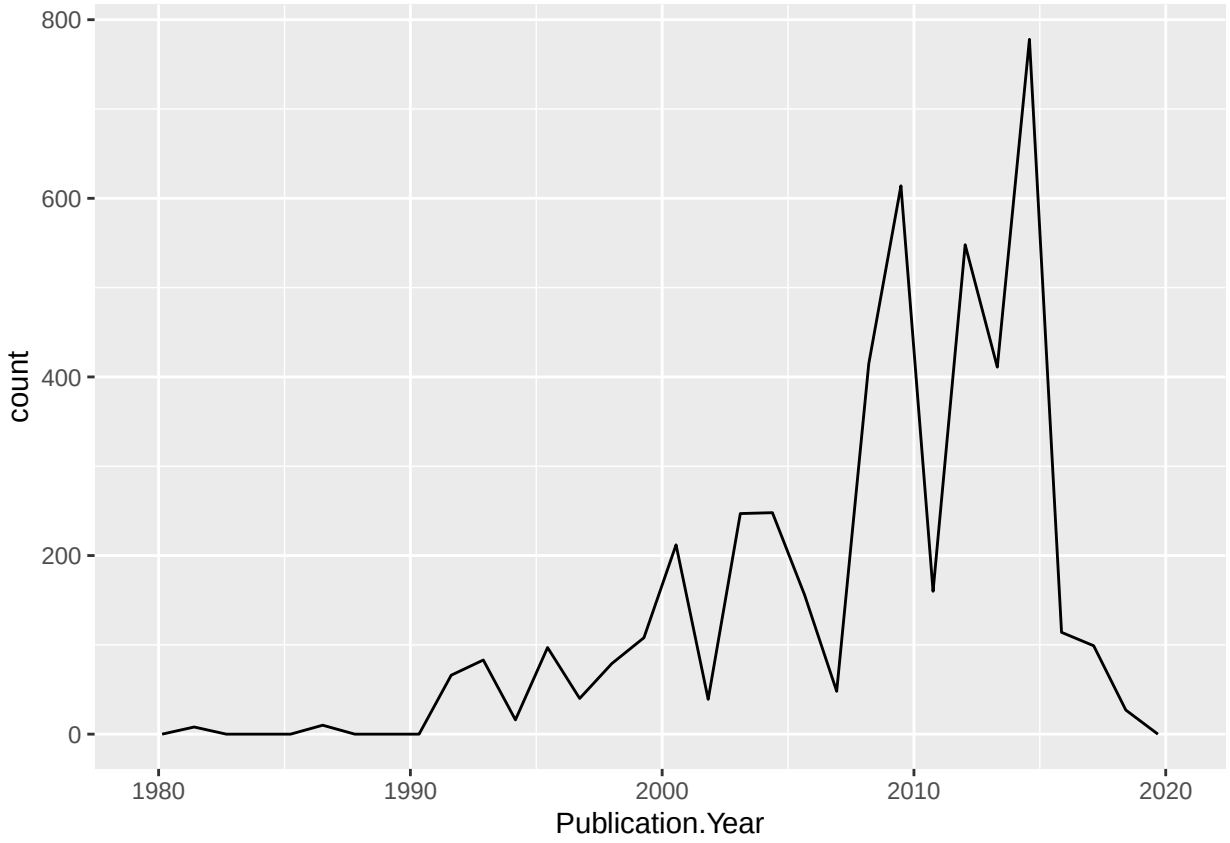
Answer:'Conc.1..Author.' is showing up as a factor. I think this is because the numbers in this column mean different things. Some of them are the concentrations of active ingredients and some are the concentration of the formula.

Explore your data graphically (Neonics)

9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
#make plot of studies by pub. year
ggplot(Neonics) + geom_freqpoly(aes(x=Publication.Year))
```

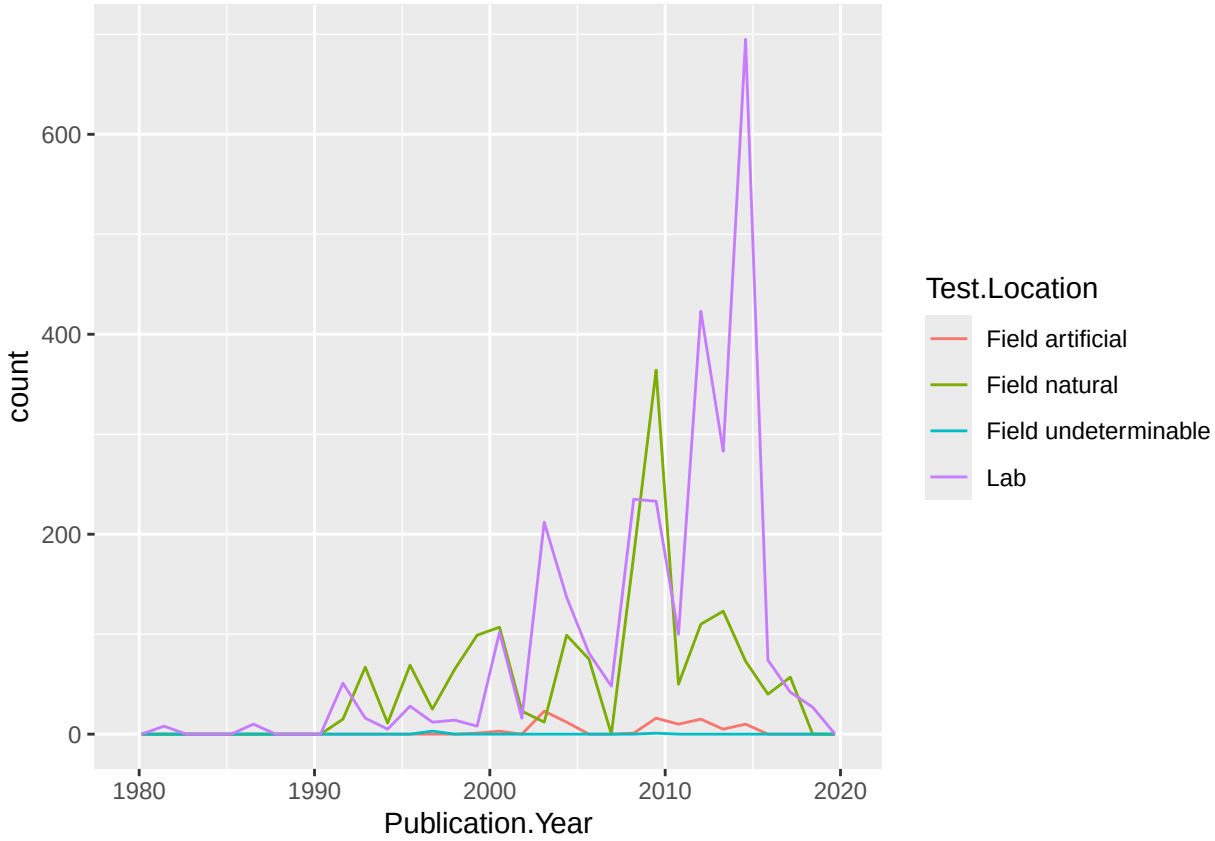
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

```
#Represent test locations with different colors
ggplot(Neonics) + geom_freqpoly(aes(x=Publication.Year,
                                    color=Test.Location))
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



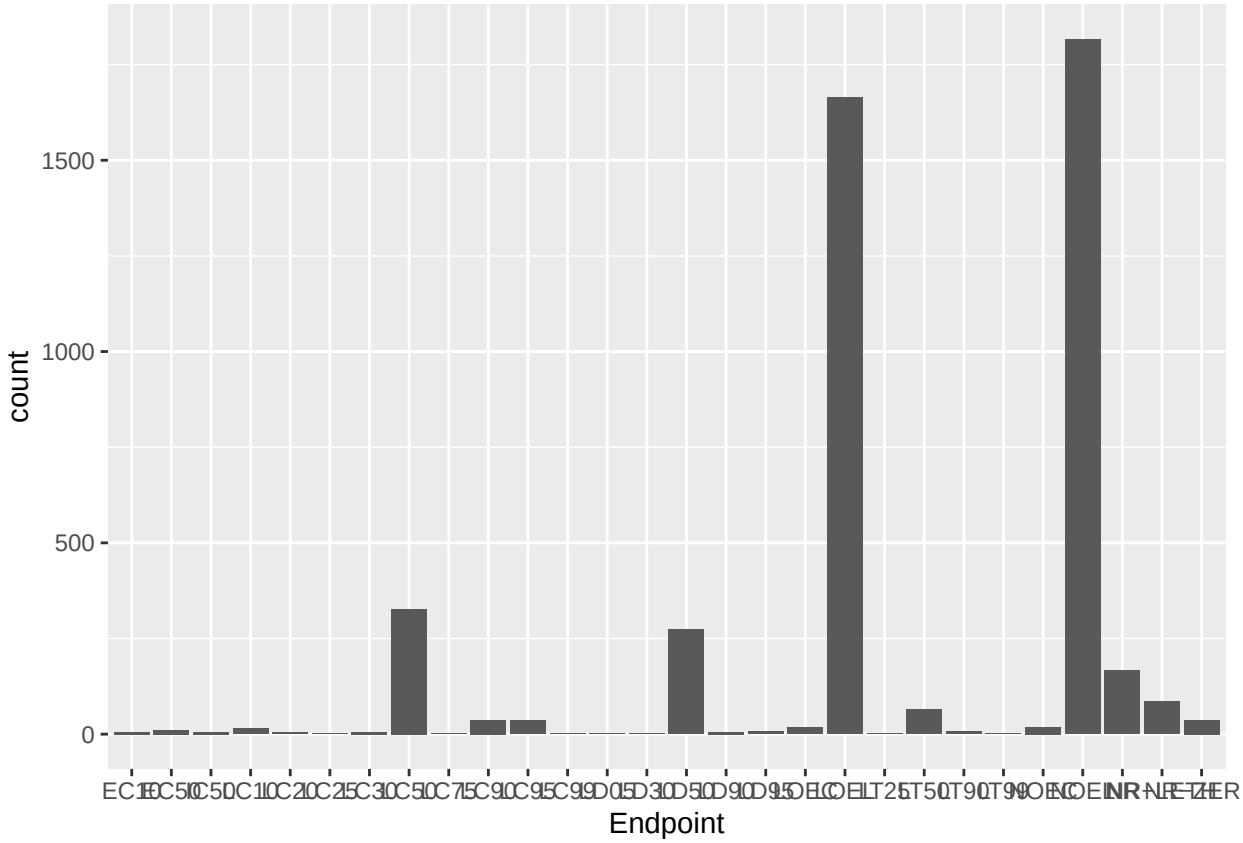
Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer:The most common test locations are Lab and Field natural. They do differ over time. Lab is the most common between 2010-2020 and Field Natural is most common from around 2007-2010

11. Create a bar graph of Endpoint counts. What are the two most common end points, and how are they defined? Consult the ECOTOX_CodeAppendix for more information.

[**TIP**: Add `theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))` to the end of your plot command to rotate and align the X-axis labels...]

```
#bar graph of Endpoint counts
ggplot(Neonics, aes(x=Endpoint)) + geom_bar();
```




```
                theme(axis.text.x = element_text(,
                angle = 90, vjust = 0.5, hjust=1))
```

```
## List of 1
##  $ axis.text.x:List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 1
##   ..$ vjust        : num 0.5
##   ..$ angle        : num 90
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi FALSE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi FALSE
##  - attr(*, "validate")= logi TRUE
```

Answer:The two most common endpoints are LOEL and NOEL. LOEL is the lowest concentration of insecticide that had an observable effect on the insects; while, NOEL is the highest concentration of insecticide that produced no observable effect on the insects.

Explore your data (Litter)

12. Determine the class of collectDate. Is it a date? If not, change to a date and confirm the new class of the variable. Using the `unique` function, determine which dates litter was sampled in August 2018.

```
#What is the class of collectDate?
str(Litter$collectDate) #collectDate is a function
```

```
##  Factor w/ 2 levels "2018-08-02","2018-08-30": 1 1 1 1 1 1 1 1 1 1 ...
```

```
Litter$collectDate <- as.Date(Litter$collectDate, format = "%Y%m%d") #changed collectDate to a date
unique(Litter$collectDate)
```

```
## [1] NA
```

13. Using the `unique` function, determine how many different plots were sampled at Niwot Ridge. How is the information obtained from `unique` different from that obtained from `summary`?

```
#using the 'unique' function vs the 'summary' function
unique(Litter$plotID)
```

```
##  [1] NIWO_061 NIWO_064 NIWO_067 NIWO_040 NIWO_041 NIWO_063 NIWO_047 NIWO_051
##  [9] NIWO_058 NIWO_046 NIWO_062 NIWO_057
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 ... NIWO_067
```

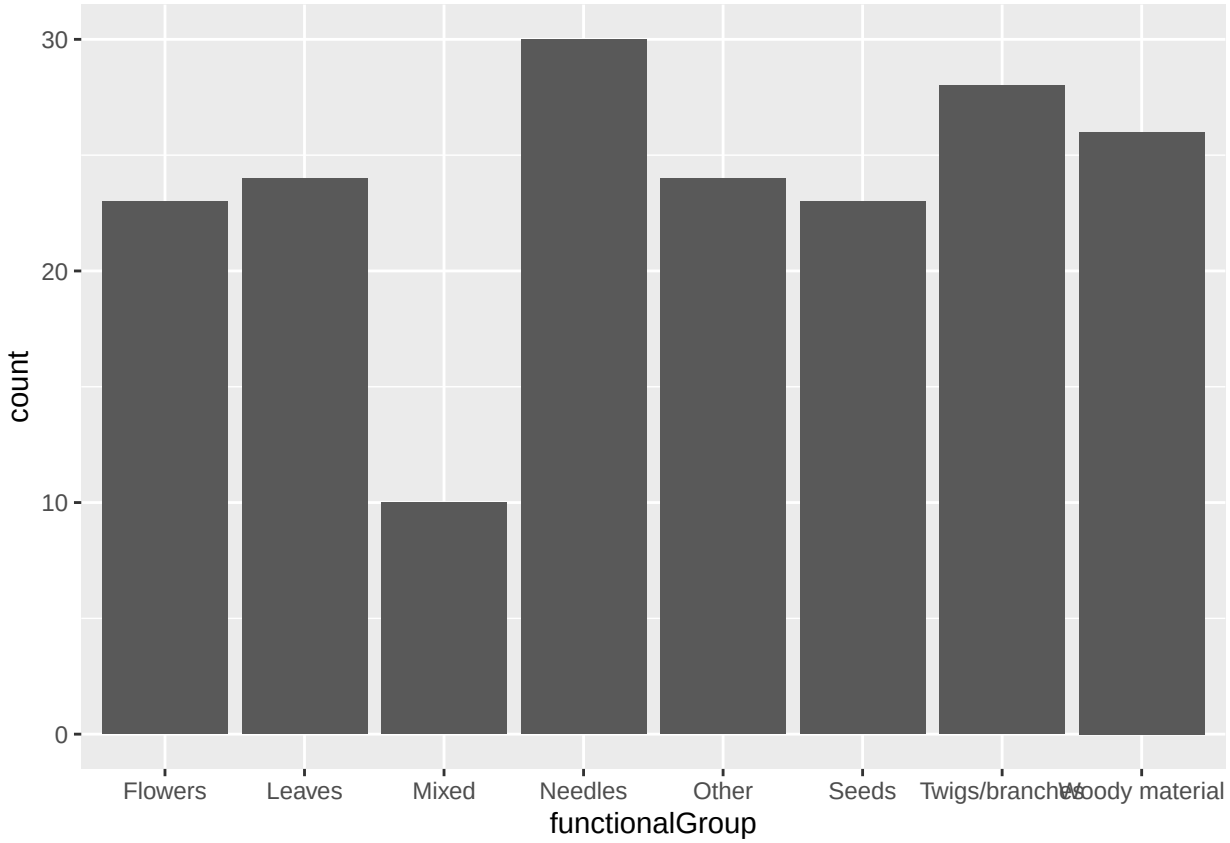
```
summary(Litter$plotID)
```

```
## NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 NIWO_058 NIWO_061
##       20       19       18       15       14        8       16       17
## NIWO_062 NIWO_063 NIWO_064 NIWO_067
##       14       14       16       17
```

Answer:12 plots were sampled at Niwot Ridge. The information obtained from 'unique' is the same data type as what you put into it but with the duplicate items gone. 'summary' shows you how many entries of each item there are in the data set.

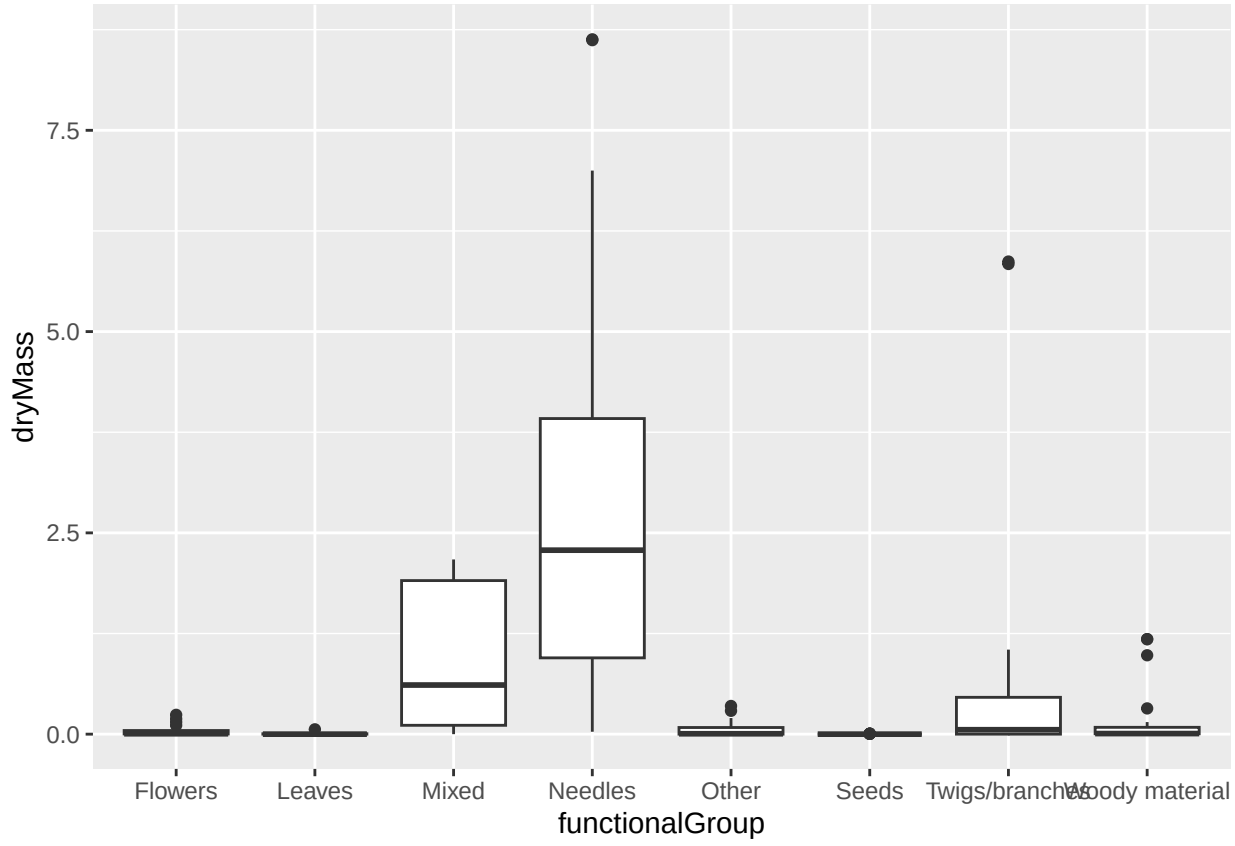
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
#bar graph of funcionalGroup
ggplot(Litter, aes(x=functionalGroup)) + geom_bar()
```

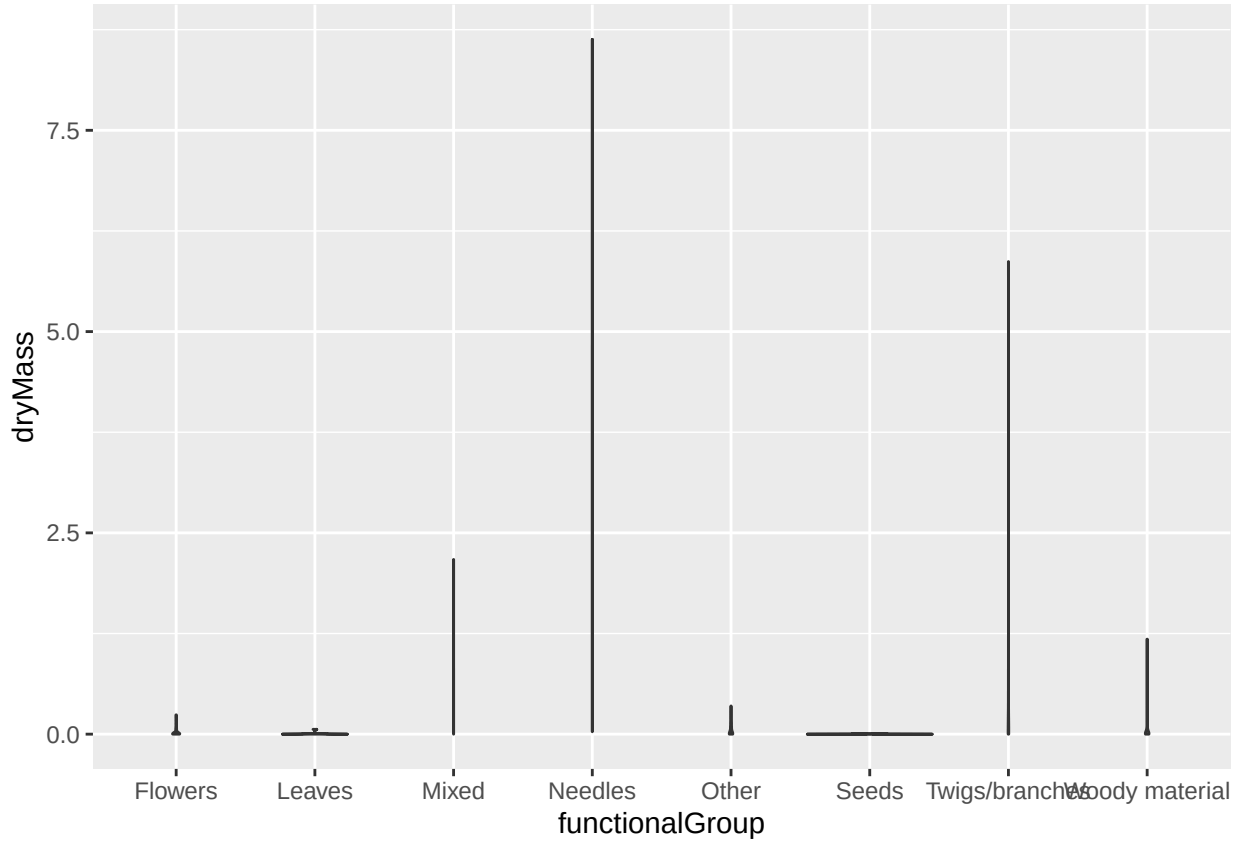


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```
#boxplot and violin plot of dryMass by functionalGroup
ggplot(Litter, aes(y=dryMass, x=functionalGroup)) + geom_boxplot()
```




```
ggplot(Litter, aes(y=dryMass, x=functionalGroup)) + geom_violin()
```



Why is the boxplot a more effective visualization option than the violin plot in this case?

> Answer:This data is not the best for a violin plot because it shows up as lines. It looks much better in a box plot

What type(s) of litter tend to have the highest biomass at these sites?

> Answer:Needles tend to have the highest biomass